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VEGETABLE RESEARCH RESULTS 2000

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INTRODUCTION

This report summarizes the results of several vegetable studies conducted during 2000. Weather data for the 2000 growing season is included at the end of this report.

The excellent cooperation of branch/farm managers and employees Ken Scaife, Sean Mueller, Frank Thayer, Mark Schmittgen, Darren Johnson, Ken DeWeese and Dave Holt is greatly appreciated. We hope that this type of information is of benefit to the vegetable industry in Ohio and the Great Lakes region. Your comments and suggestions for future efforts are always welcome.

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Landmark Plastic Corporation

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Paclobutrazol Seed Soak for Height Control in Processing Tomato Transplant Production

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Objective:

Stretching and legginess in processing tomato transplants becomes a problem when field planting in the spring is delayed due to weather conditions. Increased internode length and thin, weak stems can also be caused by cloudy or warm weather during transplant production. Difficulties in mechanical transplanting and field survival are challenges that processing tomatoes growers face with increased transplant heights. We investigated the use of paclobutrazol (Bonzi™) on processing tomato plants to control height and stretching in the transplant phase. We compared several concentrations of Bonzi used as a seed soak prior to sowing (Pasian and Bennett, 1999). Plants were then transplanted to the field to determine any effects on flowering and time to harvest, yield, and fruit characteristics.

Materials and Methods:

Tomato seeds ('OX150') were soaked in paclobutrazol solutions at 0, 500 and 1000 ppm for 6 or 16 hours. Seeds were dried back for at least 16 hours at 25°C before sowing into 338 plug trays. Transplant height measurements and survival were recorded. On June 10, 2000, transplants were established in the field at the Veg Crops Branch near Fremont, OH in a randomized complete block design with 3 replications of each concentration/seed soak treatment. Standard production practices for the midwestern U.S. (disease/insect management, fertilizer rates, weed control, etc.) were followed. Plots were harvested on September 19, 2000. Final yield, percent red fruit, average fruit weight and culls were recorded.

Results:

Significant differences in transplant height due to Bonzi™ treatment were recorded 10, 14, 21, 28, 35 and 56 days after seeding (DAS) into plug trays (Table 1). At field transplanting (56 DAS), plants showed a significant difference in internode length and stem diameter. Shorter plants and internode lengths as well as thicker stems was observed at the time of transplanting to the field. Inclement weather in late May 2000 made it necessary to hold these transplants 2-3 weeks longer than desired. However, one month after transplant, no differences were noted in plant ht, stem diameter or internode length. Yield results show no differences in red, green, and cull fruits as well as percent red fruit and average fruit weight (Table 1). While paclobutrazol seed soaks controlled the height of transplants while in the greenhouse, no differences were present one month after transplanting to the field or in final yield results. A trend for higher percent red fruit ($p=0.07$) was noted for transplants from water or paclobutrazol soaked seeds (86-90% red) compared to transplants from the dry seed control (80% red). Further studies on this seed treatment for improved use of transplants are planned.

References:

Pasian, C.C. and M.A. Bennett. 2001. Paclobutrazol soaked marigold, geranium, and tomato seeds produce shorter seedlings. HortScience 36:xx-xx. (accepted for publication)

Pasian, C.C. and M.A. Bennett. 1999. Seed coats as plant growth regulator carriers in bedding plant production. Acta Hort. 504:93-97.

Acknowledgement:

We would like to thank the *Mid-America Food Processors Association* for their support of this project.

Table 1. Paclobutrazol Seed Soak for Height Control in Processing Tomato Transplant Production - 2000 (Veg Crops Branch, Fremont, OH)

Cultivar: 'OX150'

Treatment	10 DAS Ht (cm)	10 DAS % emerg.	14 DAS Ht (cm)	14 DAS % emerg.	21 DAS Ht (cm)	21 DAS % emerg.	28 DAP Ht (cm)	35 DAS Ht (cm)	At transplant (8 wks. after seeding) Ht. (cm)	At transplant % emerg.	At transplant Internode length (cm)	At transplant Stem diam. (mm)
Dry seed control	2.5	88	2.5	95	5.6	95	15.8	19	20.1	95	3.5	3.4
Water soak - 6 hrs	2.1	89	2.7	90	5.0	91	14.6	19	20.1	91	2.6	3.3
500 ppm - 6 hrs.	1.4	43	1.9	86	3.8	90	8.6	11	14.0	90	1.3	4.1
1000 ppm - 6 hrs.	1.5	35	1.6	83	2.5	86	7.3	11	12.9	86	0.8	4.3
Water soak - 16 hrs.	2.4	92	2.8	94	5.7	94	15.0	17	20.2	94	2.7	3.4
500 ppm - 16 hrs.	1.6	57	1.8	89	3.0	92	8.2	11	12.1	92	0.9	4.3
1000 ppm - 16 hrs.	1.4	53	1.9	90	3.7	91	8.0	11	12.2	91	0.8	4.7
LSD (0.05)	0.16	13.3	0.22	5.9	0.30	5.1	1.23	1.0	1.98	5.1	0.74	0.26
CV	25.7	35.9	21.0	5.4	29.0	4.2	33.3	26.1	24.3	4.2	61.5	13.9

Treatment	1 month after transplant Plant ht. (cm)	1 month after transplant Stem diam (mm)	1 month after transplant Internode lgth (cm)	Yield Red T/A	Yield Green T/A	Yield Cull T/A	Yield Avg. fruit size (oz.)	Yield Percent red
Dry seed control	39.6	6.9	7.3	23.2	3.2	3.1	2.3	80
Water soak - 6 hrs	38.8	7.3	7.6	28.6	3.2	1.2	2.2	86
500 ppm - 6 hrs.	41.4	7.1	7.3	29.9	2.7	1.5	2.3	88
1000 ppm - 6 hrs.	41.1	7.3	7.2	32.9	3.0	1.2	2.2	89
Water soak - 16 hrs.	35.8	7.2	7.0	27.0	3.2	1.0	2.3	87
500 ppm - 16 hrs.	39.0	7.2	6.9	28.4	2.5	0.6	2.3	90
1000 ppm - 16 hrs.	39.9	7.5	7.0	24.3	2.5	1.0	2.0	86
LSD (0.05)	NS	NS	0.35	NS	NS	NS	NS	NS
p value	0.154	0.251		0.175	0.917	0.362	0.596	0.068
CV	6.7	4.2		27.9	47.6	96.5	12.4	50.0

Comparison of Organic and Inorganic Mulches for Heirloom Tomato Production

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Introduction

Many tomato growers face challenges in producing their crops due to stricter environmental regulations and fewer chemicals available for weed control. There is a demand for cultural practices that reduce chemical inputs and synthetic materials (Abdul-Baki et al., 1996). Such production practices need to focus on weed control, reducing soil erosion, and maintaining soil moisture and structure while producing high quality fruit and maintaining profitable yields. Plastic mulches have been used in vegetable production to increase soil temperatures, reduce weed pressure and increase yields (Lamont, 1991). However, disposal of this material can be costly and while adding nothing to the soil structure or fertility (Stout and Clemence, 1971). Use of cover crops and living mulches has produced mixed results. Good cover crop or living mulch management requires a balance between effective weed control and competition with the crop being produced. Organic mulches may be a feasible option for weed control and can be as effective as herbicides in suppressing weeds (Ozores-Hampton, 1998). Heirloom varieties, once traditionally grown in backyard gardens, are becoming more popular among commercial tomato growers due to increased demand from consumers. These older varieties are mainly indeterminate in habit, open-pollinated and offer unusual colors, shapes and sizes. Since most heirloom tomatoes at present are grown on small acreage, the addition of organic mulches may be a feasible practice for growers.

Objectives

To test organic and inorganic mulches along with a bare-ground control with and without pesticide inputs on an heirloom tomato cultivar 'Nebraska Wedding'. Treatments were evaluated for: marketable yield, soil temperatures, weed density and biomass, and decomposition rate of organic mulches.

Methods and Materials:

Plots were established at the OSU Waterman Ag and Natural Resources Laboratory, Columbus, Ohio on June 1, 2000 in a RCB design with 5 mulches (black plastic, shredded newspaper, wheat straw, composted landscape bark and bareground control) and 2 pesticide input levels: Pre-emergence herbicide (Dual Magnum, Sencor, Treflan) plus fungicide applications (Bravo, Benlate, Quadris) as needed throughout the season or no pre-emergence herbicide or fungicide applications. Each treatment was planted in 4 replications. Drip irrigation tape was applied to all plots placed under the mulch. Rows were 7.6 m long, spaced 1.5 m apart. Each row contained 5 plants spaced 0.9 m apart (Fig. 1). Organic mulches were applied to the tops of raised beds at a depth of 10 cm. Soil temperatures were taken every morning at approximately 8 AM from soil thermometers inserted 5 cm into the soil. Seven-week-old transplants were hand planted into plots. Plants were staked and tied using the Florida-weave method. Plots were harvested weekly from August 22 to September 22. Marketable and cull fruit number and weight were recorded. Weed density and shoot biomass were collected on October 2 from two $0.5m^2$ areas from each raised bed. Weed counts and dry weights were recorded. Organic mulch decomposition rate was calculated by placing nylon bags filled with 125 g of mulch in the field and collecting bags every three weeks for dry weight measurements.

Results and Discussion:

Marketable yields for the 10 treatments ranged from 3.4 to 50 MT/ha (Fig. 2). Highest marketable yields were achieved with shredded newspaper mulch, regardless of pesticide input. Mulch x herbicide interactions were not significant for yield. Bareground control with no pesticide inputs resulted in the lowest yields. Although newspaper produced the lowest soil temperatures, on average, of the 3 organic mulches (Fig. 3), yields with shredded newspaper produced the highest yields for treatments with low or high pesticide input.

Mulch x pesticide interaction was significant for weed density and biomass (Figs. 4,5). Bare-ground controls with no pesticide inputs resulted in the highest weed densities and biomass. Weed densities and biomass were greater in the low vs. high pesticide input plots (Figs. 4,5). Predominant broadleaf weeds were *Amaranthus* spp., common lambsquarters, common purslane and hairy galinsoga.

Newspaper suppressed weeds more than any other organic mulch with both low and high pesticide inputs while producing the highest yields. This may be due to the fact that newspaper had the lowest decomposition rate (Fig. 6) and may have formed a better barrier against weed emergence. Although plastic mulch produced the highest soil temperatures, it produced the lowest yields, compared to the organic mulch treatments for low and high input levels.

In an attempt to reduce chemical inputs for tomato production, the effects of organic mulching materials, especially with reduced chemical inputs may be a viable option for small-acreage vegetable growers.

Fig. 1. Organic mulches were applied to a depth of 10 cm to the tops of raised beds.

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for their financial support of this project.

Fig. 2 Marketable yield for 'Nebraska Wedding' tomatoes

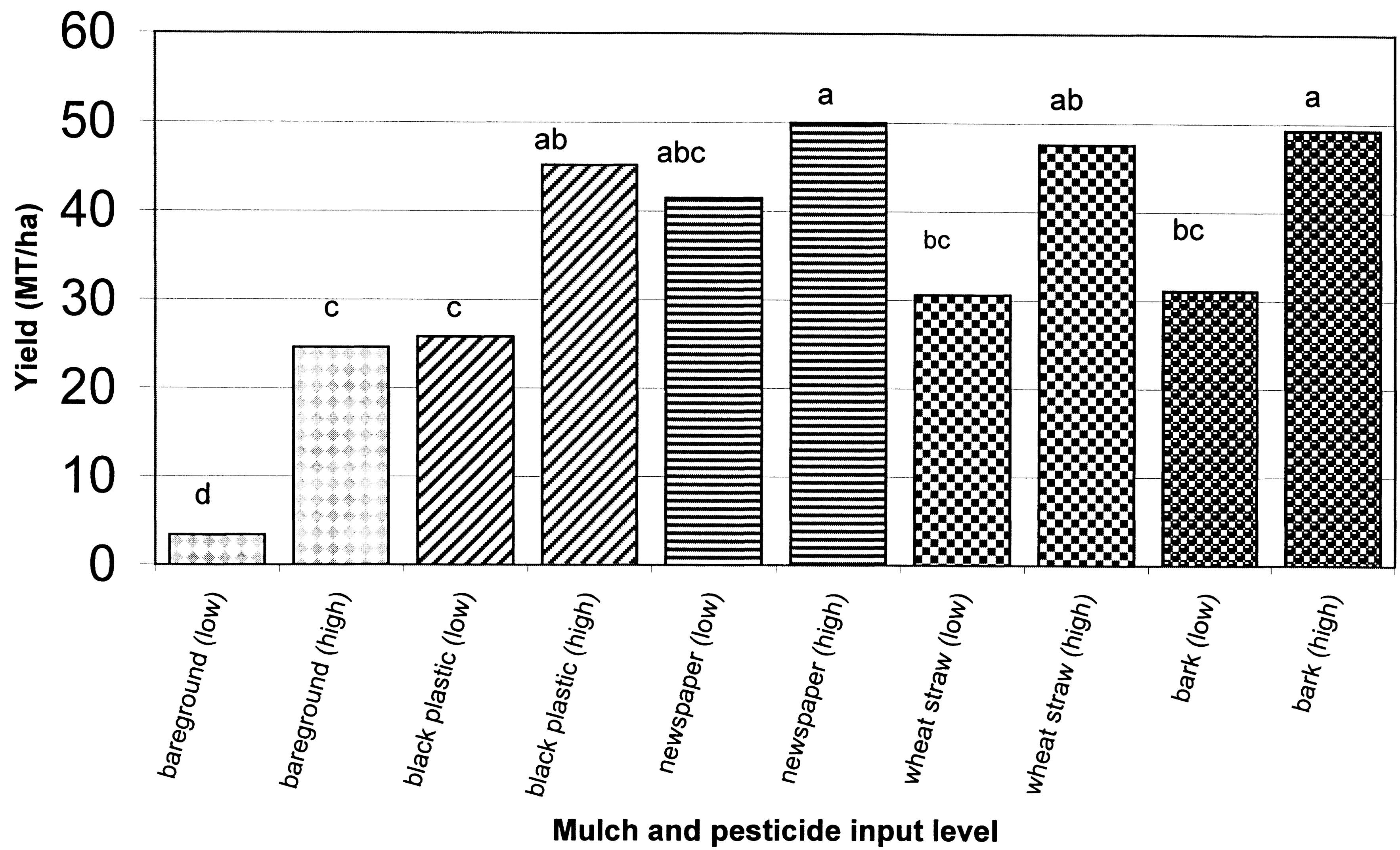


Fig. 3 Soil temperatures 5 cm depth

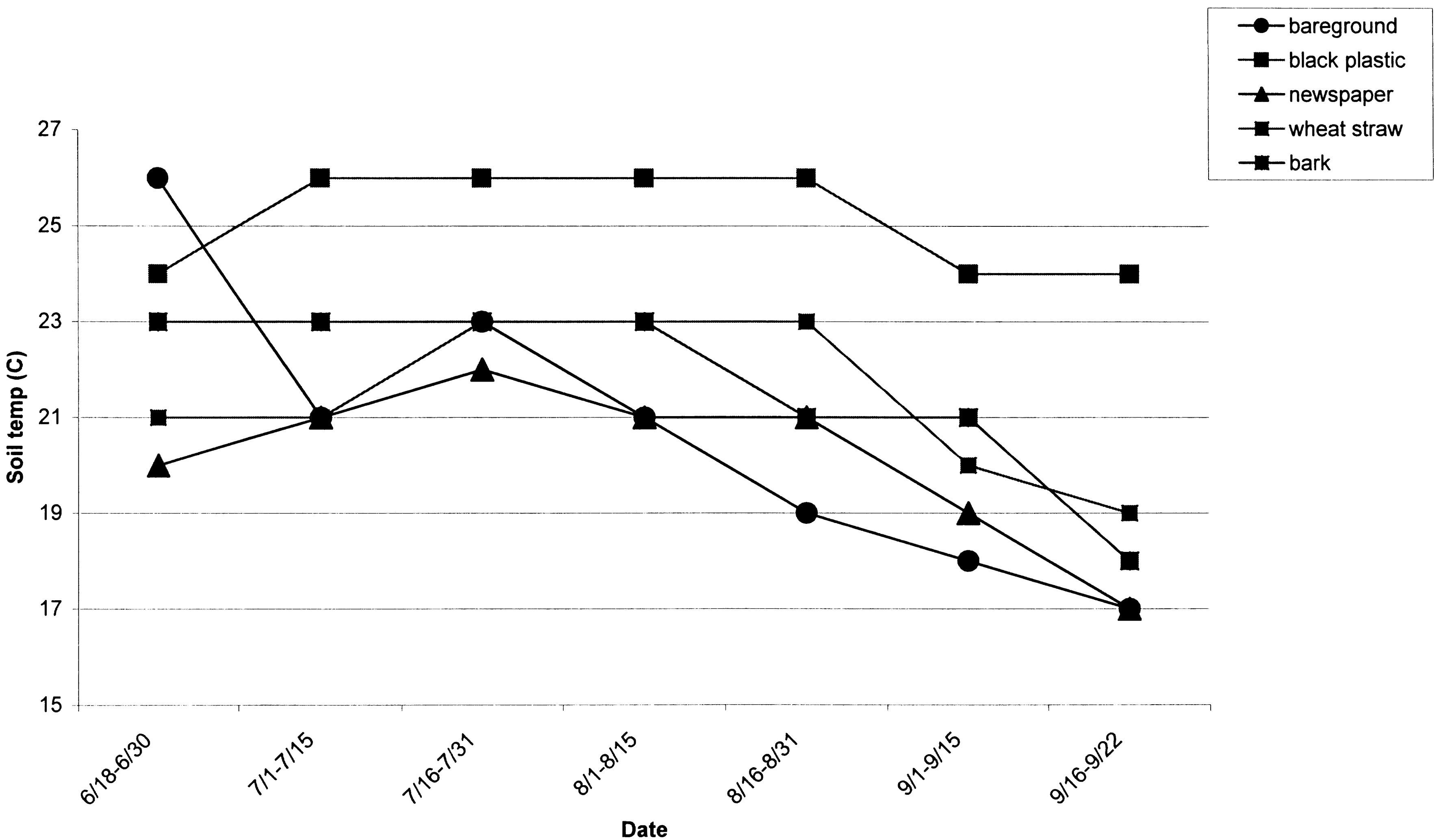


Fig. 4 Broadleaf weed density

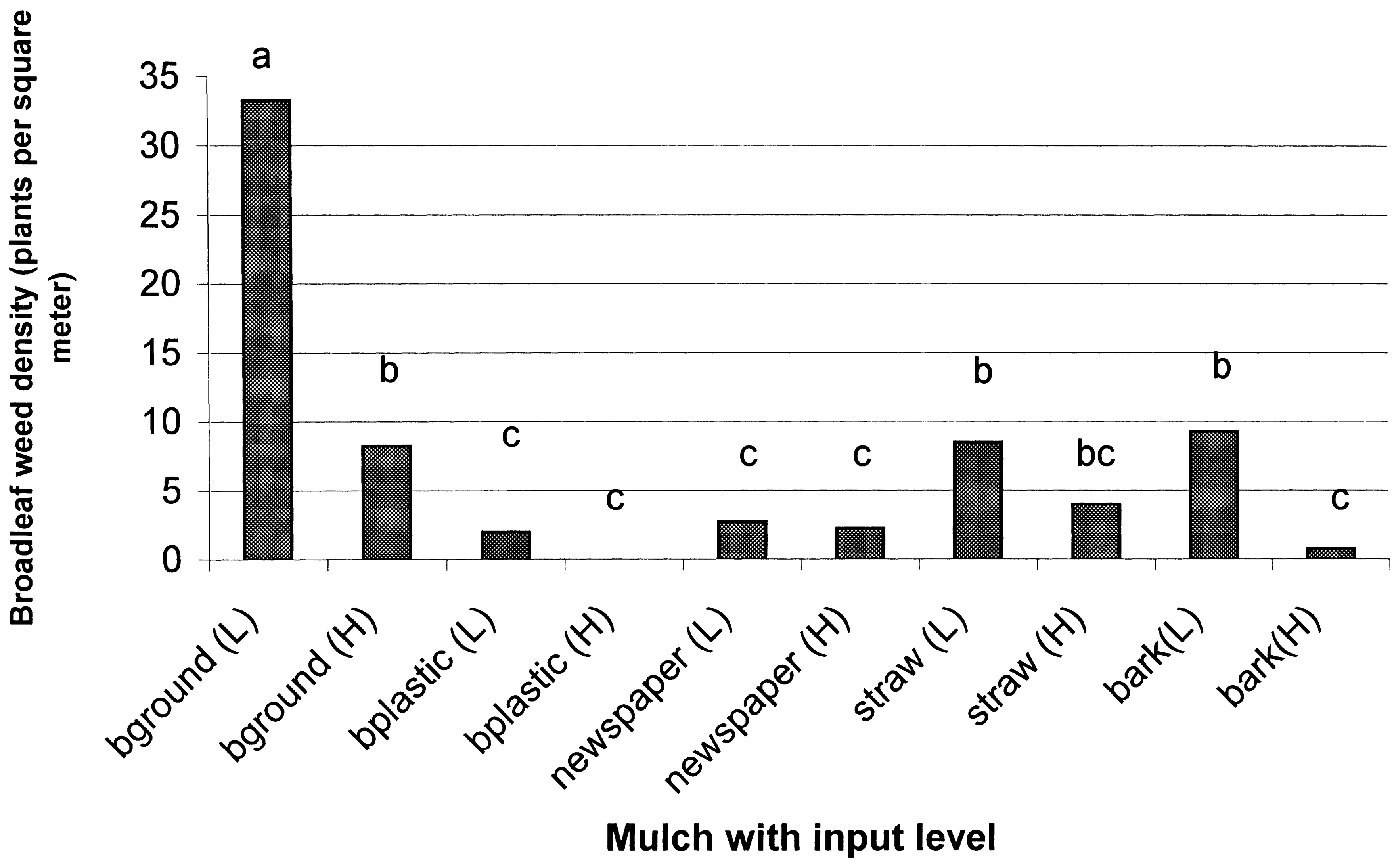


Fig. 5 Broadleaf weed biomass

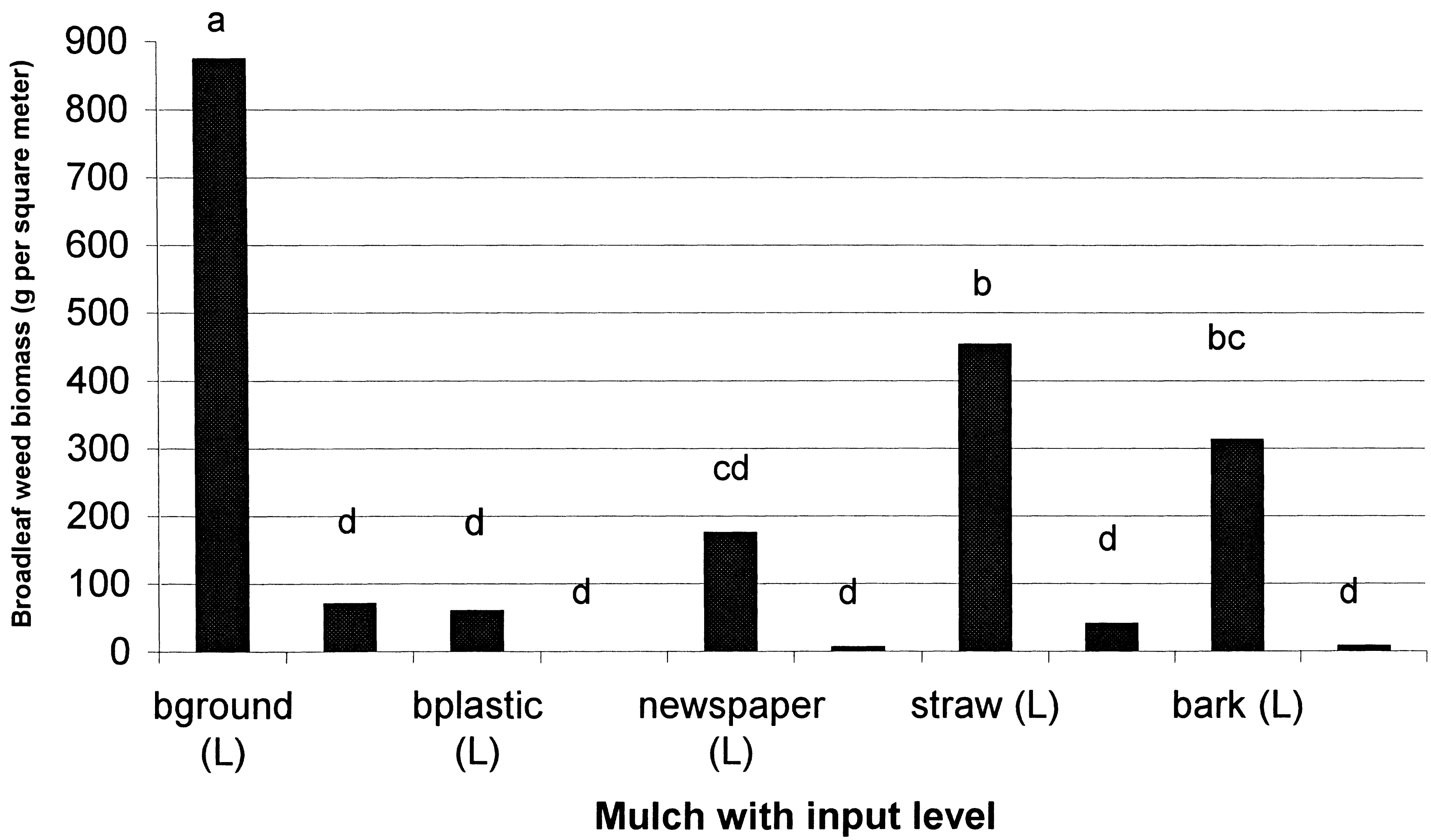
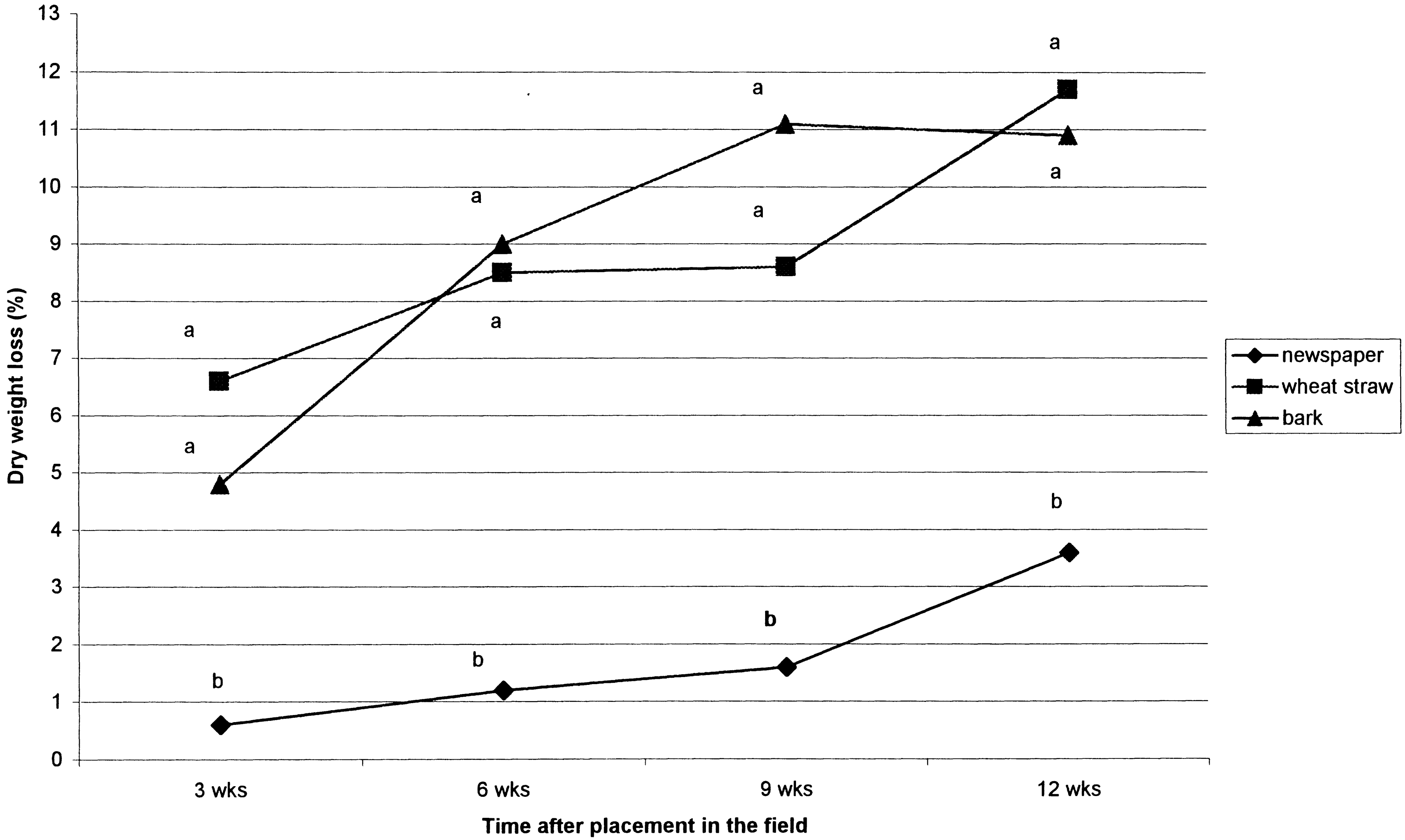


Fig. 6 Decomposition rate of organic mulches



Total antioxidant capacity and germination of normal and lycopene-enhanced tomato (*Lycoperiscon esculentum* Mill.) seeds during development and maturation.

Co-Investigators: Gerardo Ramírez Rosales, Dr. Mark Bennett and Dr. David Francis.

Introduction

There is considerable literature in areas such as human health and food science on total antioxidant capacity; however, the information available for seeds is scarce. Particularly important is to determine whether there is a relationship between total antioxidant capacity and seed longevity and deterioration.
The maximum seed quality in tomato is obtained when fruits reach red color; however, lycopene-enhanced genotypes might follow a different pattern fruit and seed development as measured by maximum seed quality.

The objectives of this study are to evaluate the total antioxidant capacity during development and maturation of tomato seeds and to evaluate whether early stages of fruit development have better seed quality in high lycopene genotypes.

MATERIALS AND METHODS

Plant Material

Two tomato genotypes that differ in seed vigor were used in this study. The first genotype was the open pollinated variety "OH 8245", which has normal lycopene content (8-10 mg/100 g DW). The second was genotype "T4099", which has high lycopene content (25 mg/ 100 g DW. This study was carried out with seed produced in greenhouse (Winter 2000).

Seed germination, vigor and longevity.

Seed germination was evaluated by the standard germination test. Four replications of 50 seeds each were planted for each treatment in Petri dishes, which were placed in a germination chamber at 25 °C. Counts were made daily to determine the germination index, which was calculated by dividing the number of seeds that germinated in a specific treatment by the number of days after planting. Seed vigor was evaluated by the Saturated Salt Accelerated Aging test.

Antioxidant Capacity Assay

The antioxidant capacity assay was assayed as described by Miller et al. (1996). This methodology is based on the ability of some substances to scavenge the $ABTS^{\cdot+}$ radical cation, compared with a standard antioxidant (Trolox) in a dose -response curve.

Statistical Design

The statistical design was a completely randomized design with factorial arrangement with four replications. The complete set of treatments equaled to ten, which included two genotypes ("OH 8245" and "T4099"), and five maturation stages (green mature, breaker, pink breaker, red mature and over-ripe). The data expressed in percentage were transformed with arc sin root square. The analysis of variance and mean comparisons were carried out with the SAS software.

Results and discussion

Differences were observed for the total antioxidant capacity between genotypes and maturation stages as measured through the TEAC value (data not shown). In addition, there were significant differences among genotypes, maturation, genotype*maturation for most of the seed quality variables (Table 1) Similar results were found by Valdes and Gray (1998). Valdez and Gray had found differences for seed quality among fruit maturation stages; seeds from red fruits had maximum seed germination. However, for the variety "T4099" greater seed quality was observed with early stages of fruit development (Tables 2 and 3). It has been reported that high lycopene genotypes, have germination problems (Berry et al.; 1991). However, the precise cause has not been determined. It is possible that elevated levels of lycopene affect the synthesis of germination promoters such as gibberellins. Thus, fruits that have not developed a maximum red color, and therefore maximum lycopene level, might have adequate levels of gibberellins and consequently better seed germination.

There were highly significant differences among maturation stages for seed vigor measured through SSAA when count was conducted at five days after that the germination test was initiated. After 14 days (final count), no significant differences were observed

(Table 1). This suggests that SSAA affected the speed of germination more than the final germination. As observed for standard germination and germination index, in "T4099" early stages of fruit development were less affected by SSAA than red and over-ripe stages (Table 4). Once again, in the early stages of fruit maturation, the synthesis of lycopene might have little effect on seed germination promoters.

Table 1. Mean squares and significance for Standard Germination (SG), Germination Index (GI), and Saturated Salt Accelerated Aging (SSAA) of two tomato genotypes harvested at five different fruit maturation stages.

Source	DF	SG	GI	SSAA(5d)a	SSAA(14d)
genotype	1	0.045**	355.072**	0.980**	0.033**
maturation	4	0.022*	4.258**	0.008**	0.002
genotype*maturation	4	0.057**	5.827**	0.007**	0.008**
error	30	0.057	0.743	0.001**	

** Highly significant difference at alpha level of 0.01
* Significant difference at alpha level of 0.01

Table 2. Mean comparison for the combination of genotypes x maturation stages for Germination Index (GI)

genotype	Maturation	GI
OH 8245	Red Mature	19.5 A
OH 8245	Over-Ripe	18.9 AB
OH 8245	Breaker	18.4 AB
OH 8245	Pink Breaker	18.2 B
OH 8245	Green Mature	15.8 C
T4099	Breaker	13.1 D
T4099	Pink Breaker	12.5 D
T4099	Green Mature	12.2 DE
T4099	Red Mature	12.2 DE
T4099	Over-ripe	11.8 E

Means with the same letter are not significantly different at alpha level of 0.05

Table 3. Mean comparison for the combination treatments genotypes x maturation stages for Standard Germination (SG)

genotype	Maturation	SG
OH 8245	Red Mature	100 A
OH 8245	Over-Ripe	96 B
T4099	Breaker	96 B
OH 8245	Pink Breaker	95 BC
T4099	Mature Green	92 BCD
T4099	Pink Breaker	91 BCDE
T4099	Red mature	90 CDE
OH 8245	Breaker	90 DE
OH 8245	Mature Green	87 DE
T4099	Over-ripe	85 E

Means with the same letter are not significantly different at alpha level of 0.05

Table 4. Mean comparison for the combination genotypes x maturation stages for Saturated Salt Accelerated Aging (SSAA)

Genotype	Maturation	SSAA
OH 8245	Red Mature	97 A
OH 8245	Pink breaker	96 A
OH 8245	Over-Ripe	96 A
OH 8245	Breaker	85 B
T4099	Mature Green	83 B
T4099	Pink Breaker	83 B
T4099	Breaker	82 B
OH 8245	Green Mature	81 B
T4099	Red Mature	75 BC
T4099	Over ripe	62 C

Means with the same letter are not significantly different at alpha level of 0.05

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SWEET CORN SEED TREATMENT AND SEEDLING ESTABLISHMENT TRIAL

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Objective:
Field test 15 chemical seed treatments plus an untreated control on 2 cultivars of sweet corn 'Even Sweeter' (sh2) and 'July Gold' (se) to determine the best seed treatments for optimum stand establishment.

Materials and Methods:
Plots were established at the Waterman Ag and Natural Resources Laboratory in Columbus (4/27/00) and at the Vegetable Crops Branch (VCB) in Fremont (5/6/00). Soil types in Columbus were Crosby silt loam and Kokomo silt loam. Soil type in Fremont was Hoytville silty clay loam. At each location, four replications of 100 seeds per rep were mechanically planted using a cone seeder. Seeds were planted approximately 5 inches apart in a randomized split plot design. Rows were spaced 30 inches apart. All pre-plant fertilizer and herbicide applications followed standard practices for Ohio. When plants reached the 5-6 leaf stage, stand counts were taken to determine effective seed treatments for optimum stand establishment. Percent of final stand showing symptoms of Stewart's wilt was recorded two months after seeding for the se and sh2 plots in Columbus only.

Results and Discussion:
Stand counts and percent Stewart's wilt (Columbus only) are shown in Table 1. There was a significant seed treatment effect at both Fremont and Columbus. Emergence of untreated 'Even Sweeter' and 'July Gold', at both locations, were lower than for seeds treated with any of the 15 seed treatments. Incidence of Stewart's wilt was much higher in the se cultivar ('July Gold') than the sh2 cultivar ('Even Sweeter'). Seed treatments which included 'Gaucho' provided some of the lowest Stewart's wilt incidence ratings for the 'July Gold' (se) plot, but incidence levels (23-29%) were still substantial

This project was part of a multi-location trial organized by the Seed Treatment Committee of the National Sweet Corn Breeders Association, a non-profit research organization. The information generated from this national study will be of value to sweet corn producers, industry personnel, consultants, farm advisers, extension plant pathologists and others interested in identifying the best performing seed treatments for optimum stand establishment.

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We would like to thank the *Ohio Vegetable and Small Fruit Research and Development Program* for their financial support of this research.

Table 1. Sweet corn seed treatment and seedling establishment, Fremont and Columbus, OH - 2000.

		'Even Sweeter' sh2			July Gold' se		
		Fremont	-------- Columbus --------		Fremont	-------- Columbus --------	
Seed Treatment	Rate (oz./cwt.)	% final stand	% final stand	% of final stand with Stewart's wilt	% final stand	% final stand	% of final stand with Stewart's wilt
Captan 400, Thiram 42S, Allegiance FL	3, 2.5, 0.75	60	56	6	71	56	64
C-400, A FL, Flo Pro-IMZ	3, 0.75, 0.5	79	72	8	62	57	59
C-400, T-42, A FL, Vitavax 34	3, 2.5, 0.75, 3	56	62	8	66	54	53
C-400, T-42, A FL, Gaucho 600	3, 2.5, 0.75, 2.4	67	61	9	72	70	29
C-400, T-42, A FL, Gaucho 600	3, 2.5, 0.75, 6.4	64	64	7	67	63	23
C-400, A FL, LS176	3, 0.75, 2.5 g ai/100 kg	64	65	7	64	59	63
LS022, LS176, A FL	2.5 g ai/100 kg, 5 g ai/100 kg, 0.75	79	72	7	72	61	53
C-400, T-42, A FL, LS273	3, 2.5, 0.75, 0.4	64	52	11	68	56	60
Maxim 4FS, Apron XL, Divident	0.08, 0.32, 0.5	77	77	4	74	62	65
C-400, Apron XL, Divident	3, 0.32, 0.5	73	67	9	63	68	59
Maxim, Apron XL, Flo Pro-IMZ	0.08, 0.32, 0.5	82	73	11	74	57	60
Maxim, Apron XL, Divident, Adage 50	0.08, 0.32, 0.5, 50 g ai/100 kg	82	80	9	69	69	36
Maxim, Apron XL, Divident, Adage 150	0.08, 0.32, 0.5, 150 g ai/100 kg	82	80	7	78	74	25
C-400, Apron XL, Divident, PolyGus	3, 0.32, 0.5	73	78	6	65	62	54
C-400, Apron XL, Divident, PolySB	3, 0.32, 0.5	81	74	11	67	61	59
Untreated check		45	33	8	37	49	61
LSD (0.05)		9.9	11.3	NS	7.8	9.7	21.3
p value				0.738			
CV		17.4	20.7	57.1	15.0	14.4	37.3

Saturated Salt Accelerated Aging (SSAA) Test for Assessing and Comparing sh2 and se Sweet Corn Seedlots

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Introduction

The accelerated aging test is a common and important seed vigor indicator for many large-seeded crops, but its utility for sweet corn (Zea mays L.) evaluation may be limited because of the anatomical and compositional differences among su, sh2 and se genotypes. The recent use of saturated salts in accelerated aging tests to reduce water uptake, microflora growth, and slow seed deterioration (Jianhua and McDonald, 1996) may also be useful in more accurately testing sweet corn genotypes.

A key component of quality assurance in the seed industry is seed vigor testing. Popular seed vigor tests include various accelerated aging and cold tests, but their usefulness for high sugar sweet corn cultivars and inbreds is marginal (Bennett et al., 1988). Pericarp damage and pathogen levels in (or on) sh2 seed are especially troublesome (Borowski et al., 1991; Parera et al., 1996). Use of a saturated salt accelerated aging (SSAA) test is hypothesized to more accurately evaluate sweet corn seeds. The SSAA test should (1) reduce water uptake, (2) minimize microflora growth, and (3) slow overall seed deterioration, thereby allowing a more precise and repeatable measurement of sweet corn seed vigor. Results with the SSAA test have been promising with a small-seeded species and we believe the test has broader applications (Jianhua and McDonald, 1996).

The current guidelines used for field corn are too severe for sweet corn seed tests. The cold test is difficult, if not impossible, to standardize because of the use of soil. The SSAA test should be easy to do, repeatable, and reliable. The results of this study could be used to develop guidelines for such a sweet corn vigor test. The objectives of this study were to test several sh2 and se genotypes using the saturated salt accelerated aging (SSAA) test and determine how closely SSAA tests for sweet corn correlate to thermogradient table results, standard accelerated aging (AA) and cold test results as well as field stand establishment.

Materials and Methods

Lab studies in 2000 have examined 13 sh2 and 13 se sweet corn cultivars, plus one field corn variety (see Table 1). An inner tray accelerating aging apparatus is used. The seeds are placed on wire mesh in a single layer with the solutions (water, NaCl) beneath them. Seeds are aged for 72 hours at various test temperatures (41, 43, 45, or 47^{o}C). Seeds are then evaluated for percentage of normal and abnormal seedlings after 7 days at 25^{o}C. Seed moisture content will be measured before and after the SSAA tests, with moisture uptake and accelerated aging results compared for seedlots of sweet corn cultivars exposed to water only or salt solution.

Results and Discussion

Percent normal germination was above 90% for all but two sh2 cultivars in our study (Table 1). Standard AA test results provided a broader range of normal seedlings (40-100%) vs. the SSAA test (71-99%) at the standard temperature of 41°C. By using a test temperature of 43° C, however, the normal seedling range was virtually identical for AA and SSAA (24-98% vs. 25-99%). Coefficient of variation (CV) values increased as test temperature increased from 41-43°C (average of 12.8 vs. 29.6), and SSAA CV values were consistently lower at all 4 temperatures in our study than those for the AA tests (Table 1).

One expected result of this experiment, that the SSAA technique would reduce seed microflora growth due to the lower RH levels using NaCl solution, was not noticeable as the seeds were removed after the initial 72 h temperature stress. This may be due to the excellent seed treatments which were commercially applied to our seed samples. Labs which test seed directly from production fields would likely observe the reduction in microflora growth using the SSAA technique.

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Table 1. Standard germination and percentage germination for one field corn (Zea mays L.) and 26 sweet corn cultivars after 7 days at 25C following accelerated aging (AA) or saturated salt AA (SSAA) in saturated NaCl (76%) solutions for 72 hours at 41, 43, 45 or 47C.

	Std. Germination			41 C						43 C					
	%			SSAA			AA			SSAA			AA		
SH2 Cultivars	*N	*A	*D	N	A	D	N	A	D	N	A	D	N	A	D
EX8413067	100	0	0	94	1	5	84	3	13	82	5	13	45	6	49
Honey Select (GH-4881)	100	0	0	96	2	2	98	0	2	88	2	10	97	2	1
Incredible	98	2	0	90	8	2	92	8	0	90	8	2	72	17	11
Kandy Plus	100	0	0	99	1	0	100	0	0	99	1	0	86	5	9
Spring Treat	100	0	0	93	7	0	94	2	4	84	6	10	93	1	6
Summer Flavor #64Y	98	1	1	81	7	12	90	3	7	75	8	17	75	4	21
Summer Flavor #73Y	100	0	0	98	1	1	97	1	2	95	4	1	83	5	12
Sweet Cheeks	100	0	0	97	1	2	92	5	3	89	9	2	83	9	8
Tablemaster	91	2	7	78	8	14	88	1	11	85	4	11	86	4	10
Tuxedo	97	2	1	89	4	7	90	3	7	83	7	10	83	5	12
Welcome TSW	80	1	0	98	1	1	98	0	2	96	2	2	98	1	1
XP8414907	88	6	4	82	7	11	40	9	51	45	14	41	34	5	61
HMX5349	94	3	3	97	2	1	94	3	3	91	6	3	98	1	1
Pfister Hybrid #2652 (field)	97	3	0	84	6	10	72	2	26	72	5	23	24	2	74
SE Cultivars															
ACX728	97	3	0	88	7	5	89	4	7	73	1	26	82	4	14
710A	99	1	0	88	3	9	86	4	10	73	2	25	67	8	25
GSS-0966 VP (Attribute)	91	0	9	66	1	33	75	2	23	34	6	60	39	1	60
GSS-3587 VP	98	0	2	71	3	26	84	7	9	25	2	73	39	11	48
GSS-5786	100	0	0	91	2	7	78	7	15	76	4	20	49	5	46
HMX 6383S	99	0	1	96	1	3	87	6	7	75	6	19	71	14	15
HMX 8392SREC	97	3	0	99	1	0	93	2	5	93	1	6	83	8	9
Morning Star	96	1	3	93	2	5	82	9	9	69	10	22	75	5	20
Summer Sweet 7100R	99	0	1	98	1	1	90	5	5	90	3	6	68	6	26
XP8414737	100	0	0	89	4	7	75	4	21	52	7	41	44	10	46
XP8414657	99	0	1	99	0	1	98	2	0	55	2	43	58	7	35
XP8415337	99	1	0	93	4	3	77	10	13	55	9	36	58	16	26
Ice Queen	100	0	0	98	1	1	94	0	6	89	3	8	87	4	9
LSD (0.05)	NS	3.2	2.2	7.8	5.5	6.8	8.1	4.0	7.4	12.7	6.6	12.7	11.4	7.5	11.1
CV	8.3	25.4	21.2	10.8	13.2	13.9	14.9	10.1	11.9	27.3	10.3	65.9	31.9	10.1	88.5

* N=normal seedlings; A=abnormal seedlings; D=dead seedlings

Table 1. (continued)

SH2 Cultivars	-45 C SSAA N	A	D	AA N	A	D	47 C SSAA N	A	D	AA N	A	D
EX8413067	47	4	49	13	4	83	13	3	84	1	1	98
Honey Select (GH-4881)	81	9	10	72	10	18	12	8	80	11	6	83
Incredible	81	7	12	71	14	15	11	6	83	0	0	100
Kandy Plus	93	4	3	44	9	47	16	6	78	1	0	99
Spring Treat	84	2	14	90	2	8	51	13	36	69	3	28
Summer Flavor #64Y	82	3	15	57	12	31	51	8	41	15	6	79
Summer Flavor #73Y	80	8	12	31	22	47	51	11	39	0	0	100
Sweet Cheeks	89	8	3	63	12	25	79	9	12	38	14	48
Tablemaster	87	4	9	82	9	10	59	6	35	41	4	55
Tuxedo	63	11	26	63	13	24	39	11	50	19	9	72
Welcome TSW	91	5	4	92	5	3	73	9	18	40	10	50
XP8414907	49	14	37	10	4	86	29	6	65	0	0	100
HMX5349	92	2	6	89	5	6	88	2	10	58	8	34
Pfister Hybrid #2652 (field)	80	3	17	0	0	100	0	0	100	0	0	100
SE Cultivars	56	8	36	38	9	53	0	1	99	5	3	92
ACX728												
710A	55	9	36	43	15	43	1	5	94	12	15	73
GSS-0966 VP (Attribute)	44	4	52	10	2	88	0	0	100	0	0	100
GSS-3587 VP	33	2	65	11	4	85	0	0	100	0	0	100
GSS-5786	26	6	68	17	3	80	0	0	100	0	0	100
HMX 6383S	49	12	39	74	8	18	25	6	69	44	10	46
HMX 8392SREC	72	4	24	64	9	27	24	9	67	25	9	66
Morning Star	85	4	11	18	14	68	14	4	82	0	1	99
Summer Sweet 7100R	8	5	87	20	9	71	0	2	98	2	2	96
XP8414737	4	10	86	8	4	88	10	10	80	0	0	100
XP8414657	58	9	33	47	5	48	4	3	93	4	1	95
XP8415337	87	2	12	24	7	69	2	1	97	3	1	98
Ice Queen	73	6	21	66	5	29	29	10	61	12	10	78
LSD	11.3	7.3	8.4	11.1	6.3	11.9	10.9	7.2	10.7	8.9	4.9	10.3
CV	40.2	89.7	85.1	65.9	78.2	66.1	10.9	10.5	42.4	38.7	32.2	29.2

* N=normal seedlings; A=abnormal seedlings; D=dead seedlings

Paclobutrazol Seed Soak for Height Control in Cabbage Transplant Production

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Objective:

Stretching and legginess in vegetable transplants becomes a problem when field planting in the spring is delayed due to weather conditions. Increased height and thin, weak stems can also be caused by cloudy or warm weather during transplant production. Difficulties in mechanical transplanting and field survival are challenges that vegetable growers face with increased transplant heights. We investigated the use of paclobutrazol (Bonzi™) on cabbage plants to control height and stretching in the transplant phase. We compared several concentrations of Bonzi used as a seed soak prior to sowing.

Materials and Methods:

Seeds of two varieties of cabbage 'Cheers' and 'Benefit' were soaked in paclobutrazol solutions at 0, 500 and 1000 ppm for 5 or 45 minutes. Seeds were dried back for at least 16 hours at 25°C before sowing into 200 plug trays. Transplant height measurements and survival were recorded 7, 14 and 21 days after seeding. Plant height, leaf number and dry weights were recorded 28 days after seeding (DAS).

Results:

Significant differences in transplant height due to Bonzi™ treatment was recorded 7, 14, 21, and 28 DAS for both cultivars (Table 1). At 28 DAS, both 'Cheers' and 'Benefit' had significantly shorter transplants with the seed soak treatments, although no significant differences were recorded in leaf number or dry weight. Future field studies will investigate these seed soak treatments and their effect on cabbage yield and head characteristics.

Table 1. Paclobutrazol Seed Soak for Height Control in Cabbage Transplant Production - 2000.

Cultivar: 'Benefit'

	7 DAS		14 DAS		21 DAS		28 DAS		
Seed Soak	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Plant Ht. (cm)**	**Leaf Number**	**Dry wt. (g)**
Dry seed control	80	2.2	83	5.1	83	6.8	10.8	4.5	1.10
H2O - 5 min.	72	2.2	75	4.9	75	5.8	10.2	4.3	1.09
H2O - 45 min.	78	2.4	83	4.8	83	6.5	11.5	4.2	0.98
500 PPM - 5 min.	82	1.0	88	2.9	88	4.8	8.9	4.6	0.95
500 PPM - 45 min.	80	1.0	84	2.8	84	4.8	8.7	4.6	0.90
1000 PPM - 5 min.	78	0.8	84	2.4	84	4.5	8.6	4.7	0.91
1000 PPM - 45 min.	71	0.8	79	1.8	82	3.8	7.3	4.6	0.83
LSD (0.05)	NS	0.81	NS	1.99	NS	2.08	4.15	NS	NS
p value	0.62		0.428		0.516			0.334	0.335
CV	12.2	51.5	9.9	38.8	9.9	22.0	17.7	7.2	

Cultivar: 'Cheers'

	7 DAS		14 DAS		21 DAS		28 DAS		
Seed Soak	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Germination (%)**	**Plant Ht. (cm)**	**Plant Ht. (cm)**	**Leaf Number**	**Dry wt. (g)**
Dry seed control	95	2.2	95	5.1	96	8.8	10.2	3.6	0.96
H2O - 5 min.	92	1.8	95	4.6	95	8.3	10.8	3.6	1.00
H2O - 45 min.	94	2.2	95	5.1	95	8.2	10.8	3.6	1.14
500 PPM - 5 min.	89	0.8	90	2.7	90	6.2	8.7	3.7	0.95
500 PPM - 45 min.	84	0.7	90	2.7	90	6.4	8.5	3.6	0.81
1000 PPM - 5 min.	79	0.4	89	2.0	89	5.5	8.5	3.8	0.81
1000 PPM - 45 min.	82	0.5	87	2.1	89	5.1	8.4	3.9	0.84
LSD (0.05)	10.0	0.2	NS	0.61	NS	1.05	2.04	NS	NS
p value			0.476		0.361			0.635	0.338
CV	9.6	62.8	7.5	39.0	6.5	22.1	17.1	8.5	

Cover Crops for Disease Control and No-Till Pumpkins

Principal Investigators:

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Cover crops are used in high-input agronomic and vegetable production systems to reduce soil erosion, fungicide use, plant disease, and weeds. Cover crops have also been shown to increase soil organic matter, nitrogen availability, and moisture. Traditional cover crops, such as hairy vetch (*Vicia villosa*) and winter rye (*Secale cereale*), widely used in tomato production have been used in pumpkin (*C. pepo*) production with limited success. Traditional fall-sown cover crops, such as hairy vetch and winter rye, are typically killed by herbicide applications, mowing, or mechanical undercutting prior to pumpkin planting. Pumpkin growers in Ohio have asked for alternative cover crops that could be spring or fall-sown and require less input than the traditional cover crops. Annual medics (*Medicago* spp.), native to Australia, have been studied as forage crops in the upper Midwest. Annual medics with their less invasive, dense, low growth habits and drought tolerance make them potential candidates as spring-sown living cover crops in pumpkin production.

Objectives:

1. Selection of spring-sown living, fall-sown winter-killed, and spring-sown (herbicide) killed cover crop mulches for use in commercial pumpkin production.
2. Determine the effects of these cover crop mulch systems on pumpkin yield and aesthetic fruit quality.
3. Determine the effects of these 3 cover crop mulch systems on soil-borne fungal diseases such as fruit rot of pumpkin caused by *Fusarium spp.*
4. Introduce these cover crop systems to growers for use in commercial pumpkin production.

Planned scope of research:

a) Establishment, biomass development, cover crop kill, and percent ground cover determinations: In September 1999, fourteen fall-sown cover crop plots were set up in a completely randomized block design at the OSU Waterman Ag and Natural Resources Laboratory (WANRL), Columbus. In late April 2000, fourteen spring-sown cover crops treatments (Table 1) were set up in a completely randomized block design (4 reps. each) on field sites at the WANRL, Columbus, the Vegetable Crop Branch, Fremont, OARDC, and the Ohio Agricultural, Research and Development Center, (OARDC), Wooster campus. Prior to pumpkin seeding, fall and spring-sown winter rye (WR), hairy vetch (HV), WR+HV, WR+annual medic (AM), oat, oat+HV, and oat+AM were killed with and application of 2,4-D (2 pt/A) + Round Up Ultra (4 pt/A). Spring-sown AM and non-dormant perennial alfalfa (NDPA) were allowed to remain as living mulches. Biomass production was determined by collecting and drying 1/4 m^2 quadrants from each treatment at pumpkin planting and harvest. Percent ground cover was determined by visually rating ½ m^2 ground cover at each biomass collection.

b) Production, pumpkin yield and fruit quality: Pumpkin cv. 'Magic Lantern' was seeded into cover crop treatments in June 2000 by hand. Two seeds were dropped every 2 ft. to approximate standard production practices. Plots were maintained with a standard spray program of weekly applications of Bravo Ultrex @ 2.7 lb/A beginning in August. Nova 40WP @ 3.0 oz/A or Benlate 1 lb ai/A was added to the spray program to control Powdery Mildew. Sulfur-coated urea (37-0-0) was broadcasted @ 50 lb/A over entire plots and banded at vine-tip at 25 lb/A. At harvest, all fruits from each treatment were graded according to color (orange, green) and fruit with disease, and weighed to determine T/A, and percentages of marketable, green, and diseased fruit.

c) Effects of living and spring-killed cover crops on fruit rot of pumpkin: To determine the effects of cover crop on Fusarium fruit rot, 5 cover crop treatments were established in April 2000 at three commercial field sites in Wayne Co., OH. The 5 treatments included a bare soil (no fungicide), bare soil (fungicide), spring-sown oat (herbicide killed) @ 90 lb/A, annual medic mix (living) @ 60 lb/A, and non-dormant alfalfa mix (living) @ 40 lb/A. Each site had been used for pumpkin production in the 1999 growing season and each had a high level of Fusarium fruit rot (FFR). Biomass, percent ground cover, pumpkin yield, and fruit quality was characterized as previously described. At harvest, individual pumpkin fruit from each treatment were examined for FFR symptoms.

Results and Discussion:

Biomass production:
Fall-sown (Columbus): In September 1999, 14 fall-sown cover crop treatments were established (Table 1). The cover crop treatments included traditional fall-sown cover crops winter rye (WR), hairy vetch (HV), and a WR+HV mix. Also included were cover crops that would winter-kill such as oat, annual medic, and non-dormant perennial alfalfas (Table 3). Although each type of cover crop established itself prior to winter (~80-100% ground cover by killing freeze), the only effective cover crops to produce enough aboveground biomass for the following summer were the traditional ones. (Table 3).

Spring-sown (Columbus, Fremont): In late April 2000, the same 14 cover crop treatments were established at Columbus, Fremont, and Wooster. Spring-sown WR and HV were extremely poor (~45%) at producing aboveground biomass when compared to fall-sown WR and HV (~95%). Interestingly, both fall-sown non-dormant perennial alfalfa (NDPA) at Columbus survived the winter to produce partial stands, probably due to a milder winter (Table 3). Spring-sown annual medic (AM) and NDPA produced adequate biomass prior to pumpkin planting (Table 3). Prior research indicated that spring-sown living cover crop mulches such as AM and NDPA were poor at suppressing weeds. An application of 2,4DB @ 3 qt/A (Butyrac 200) about 4 to 5 weeks after sowing AM and NDPA helped to control weeds such as pigweed and lambquarter. If weed pressure was too high, weed control with living cover crop + 2,4DB was poor (Columbus).

Pumpkin yield and fruit quality:

a) Columbus: Fall-sown winter rye, hairy, vetch, and WR+HV pumpkin total weights (yield) were much higher when compared to the no cover plot (Table 3). Interestingly, total weight of WR (50.3 kg/plot) and HV(43.2 kg/p[lot) alone was greater than the WR+HV (34.4 kg/plot) mix. Although fall-sown AM and NDPA failed to produce adequate biomass yields from these plots were similar or slightly greater to the no cover control. Spring-sown living AM and NPDA produced yields much lower than all other cover crop treatments (Table 3). This was due to the competitiveness of the living mulches with the pumpkin planting for available water.

b) Fremont: Spring-sown oat, HV, WR, oat + HV, WR + HV, oat + AM, WR + AM each produced yields greater than the bare soil control, although oat, oat + HV, oat + AM were the only cover crop treatments to produce enough biomass to last season long. Yields of spring-sown AM and NDPA were much lower when compared to the no cover control This was again due to the competition between the living mulches and pumpkin plantings.

c) On-farm site: Yield at the on-farm site was similar for same treatments at each of the research farms. Yield of spring oat plots were similar to the no cover – fungicide treatment, and higher than the no cover – no fungicide treatment (Table 4). Defoliation of no cover – no fungicide treatments by powdery mildew resulted in decreased total yield. Yields of living AM mix and NDPA mix treatments were not significant, due to the competition of the living mulches with pumpkin planting (Table 4). Because of a cool, wet summer disease pressure by fusarium fruit rot was non-existent and no data on the effect of cover crop on development of the disease was collected.

Data for Wooster and 2 of the on-farm sites are not discussed, but they are similar to data from Columbus and Fremont.

Table 1. Seeding rates for cover crop treatments at Columbus*, Fremont, and Wooster in 2000.

Treatment	Scientific Name	lb/A
No Cover		none
Oat	*Avena sativa* 'Amor'	90
Oat/ Hairy Vetch	*Avena sativa* 'Amor'/ *Vicia villosa*	50 & 50 ea
Rye/ Hairy Vetch	*Secale cereale / Vicia villosa*	50 & 50 ea
Hairy Vetch	*Vicia villosa*	50
Medic- Snail	*Medicago scutellata* 'Kelson'	50
Medic –Burr	*Medicage polymorpha* 'Santiago'	40
Medic – Barrel	*Medicago truncalata* 'Sephi'	40
ND Alfalfa 711	*Medicago sativa* 'WL711WF'	40
ND Alfalfa Pio.	*Medicago sativa* Pioneer 5929	40
3 Medics	Medicago's 'Kelson' , 'Santiago' , 'Sephi'	20 ea
Medic/Oat	*Medicago scutellata* 'Kelson' / *Avena sativa 'Amor*	50 & 70
Rye	*Secale cereale*	90
Medic/Rye	*Medicage scutellata* 'Kelson' / *Secale cereale*	50 & 70

* Same treatments were established at Waterman Agricultural and Natural Resources Laboratory, Columbus OH, in September 1999.

Table 2. Seeding rates for cover crop plots established at on-farm sites in Wayne, Co.,OH in April 2000.

Treatment	Seeding Rate
No Cover - No Fungicide	none
Spring Oat 'Amor'*	90 lb/A
No Cover – Fungicide*	none
Non-Dormant Alfalfa Mix*	40 lb/A
Medic Mix*	60 lb/A

* Bi-weekly applications on 8/5 of Quadris (12.3 fl. oz/A), 8/16 Bravo Ultrex (2.7 lb/A) + Benlate (1 lb ai/A), 8/30 Quadris (12.3 fl. oz/A), 9/13 Bravo Ultrex (2.7 lb/A) + Nova 40 WP (3 oz/A).

Table 3. Average number, weight, % color of pumpkin fruit and % ground cover of 14 fall and spring-sown cover crop treatments, WANRL, Columbus, OH (Franklin Co.)

	Columbus Fall 1999										
	average number of				Average wt. (kg)				% Orange	% Ground Cover	
Treatment	Total Fruit	Orange	Green	Rots	Orange	Green	Rots	Total wt.	at Harvest	Planting	Harvest
No Cover	8.75	4.25	4.25	0.25	15.27	6.43	0.42	22.12	49%	0	0
Oat	9.5	7	2.5	0	19.43	2.69	0	22.11	74%	18	0
Oat/ HV	7.25	3.25	4	0	15.67	11.08	0	26.75	45%	92	30
Rye/HV	8.5	6.75	1.75	0	30.86	3.56	0	34.42	79%	92	83
HV	10	8.5	1.5	0	41.01	2.16	0	43.17	85%	95	57
Snail Medic	8.25	6.25	2	0	17.93	4.53	0	22.46	76%	13	0
Burr Medic	10.75	7	3.75	0	20.47	7.86	0	28.33	65%	0	0
Barrel Medic	7.5	4.75	2.75	0	17.53	7.2	0	24.73	63%	0	0
ND Pio. 5292	11	9	2	0	33.96	5.89	0	39.85	82%	41	0
ND WL711	11.5	9.25	2	0.25	37.17	5.29	0.3	42.76	80%	41	0
Medic Mix	9	6	3	0	22.53	5.57	0	28.1	66%	0	0
Oat/Medic	10.5	0.75	0	0	30.26	2.17	0	32.42	93%	15	0
Rye	11.75	9.25	2.5	0	43.83	6.46	0	50.29	79%	95	92
Rye/Medic	9	8.5	0.5	0	40.8	0.45	0	41.25	94%	95	92

	Columbus Spring 2000										
	average number of				Average wt. (kg)				% Orange	% Ground Cover	
Treatment	Total Fruit	Orange	Green	Rots	Orange	Green	Rots	Total	at Harvest	Planting	Harvest
No Cover	8	6.75	1.25	0	23.75	3.27	0	27.02	77%	0	0
Oat	9.25	5.75	3.5	0	20.38	11.52	0	31.9	62%	73	53
Oat/ HV	8.25	5.25	2.75	0.25	19.59	5.74	0	25.33	63%	70	72
Rye/HV	8.5	7.25	1.25	0	29.67	1.01	0	30.6	85%	67	75
HV	7.25	3.75	3.5	0	14.04	6.97	0	21.01	51%	45	77
Snail Medic	2.5	0	2.5	0	0	2.69	0	2.69	0	18	ND
Burr Medic	3	0.5	2.5	0	1.52	4.05	0	5.57	17%	67	ND
Barrel Medic	1.75	0.25	1.5	0	1.37	2	0	3.37	14%	76	ND
ND Pio. 5292	3.75	0	3.75	0	0	3.18	0	3.18	0	63	ND
ND WL711	1.75	0.25	1.5	0	1.37	2	0	3.37	14%	63	ND
Medic Mix	2.25	0.25	2	0	0.85	3.17	0	4.02	11%	75	ND
Oat/Medic	8.75	7.25	1.5	0	27.52	2.28	0	29.8	83%	67	53
Rye	9.75	8.75	1	0	33.86	1.25	0	35.11	88%	46	0
Rye/Medic	8	6.25	1.75	0	25.93	3.65	0	29.58	78%	53	0

Table 4. Average number, weight, % color of pumpkin fruit and % ground cover of 14 fall and spring-sown cover crop treatments grown at Fremont, OH (Sandusky Co.) and on-farm site in Wooster, OH (Wayne Co.).

	Fremont Spring 2000										
	Average number of				Average wt. (kg)				% Orange	% Ground Cover	
Treatment	**Total Fruit**	**Orange**	**Green**	**Rots**	**Orange**	**Green**	**Rots**	**Total**	**at harvest**	**Planting**	**Harvest**
No Cover	15.75	13	2.5	0.25	76.21	7.93	0.59	84.73	84%	0	0
Oat	20.5	19	1.25	0.25	110.02	2.72	0.67	113.41	94%	87	60
Oat/ HV	21	19	1.5	0.5	114	6.89	2.86	123.7	93%	80	26
Rye/HV	18.25	17.25	1	0	101.65	1.83	0	103.48	93%	63	0
HV	13.75	11.5	2	0.25	70.55	7.22	1.13	78.9	85%	46	53
Snail Medic	10	5	5	0	13.92	10.22	0	24.13	50%	50	80
Burr Medic	8.25	1.75	6.5	0	9.46	19.84	0	29.3	21%	68	20
Barrel Medic	10.25	6.75	3.5	0	31.51	10.01	0	41.52	66%	80	70
ND Pio. 5292	9.75	4.5	5	0.25	20.2	15.68	0.93	36.8	47%	62	78
ND WL711	11	6.25	4.75	0	25.93	10.82	0	36.75	57%	62	83
Medic Mix	10.33	7.67	2	0.67	35.68	4.74	0.78	41.21	79%	86	80
Oat/Medic	18.5	15.75	2.5	0.5	92.52	6.88	0.69	100.09	88%	83	28
Rye	17	14.5	2	0.5	92.08	6.59	1.41	100.08	88%	68	0
Rye/Medic	20.25	17.5	2	0.75	98.27	5.38	2.56	106.21	89%	72	0

	On-Farm Site 2000										
	average number of				Average wt. (kg)				% Orange	% Ground Cover	
Treatment	**Total Fruit**	**Orange**	**Green**	**Rots**	**Orange**	**Green**	**Rots**	**Total wt.**	**at Harvest**	**Planting**	**Harvest**
No Cover - No Fungicide	15.5	7.5	6.75	1.25	31.2	17.52	0.87	49.59	53%	0	0
Spring Oat*	16.5	11.75	4.75	0	55.53	10.08	0	65.61	71%	85%	55%
No cover - Fungicide*	17	12.75	3.25	1.5	53.53	7.94	1.59	63.1	82%	0	0
ND Alfalfa Mix*	3	0	3	0	0	3.52	0	3.52	0%	86%	78%
Annual Medic Mix*	3	0.5	2	0.5	2.7	2.42	0.83	5.95	20%	100%	78%

* Fungicide applications - 8/5 Quadris (12.3 fl oz/A), 8/16 Bravo Ultrex (2.7 lb/A) + Benlate (1 lb ai/A), 8/30 Quadris (12.3 fl oz/A) 9/13 Bravo Ultrex (2.7 lb/A) + Nova 40WP (3 oz/A).

Weather Data – 2000

Vegetable Crops Branch, Fremont, OH

Month	Rainfall (inches)	Long-Term Rainfall Average (inches)
April	2.66	3.44
May	5.08	3.60
June	7.49	4.00
July	3.96	3.90
August	2.81	3.40
September	4.67	3.00

	Air Temperature (°F)			Long-Term Normal (°F)
	Minimum	Maximum	Average	Average Temperature
April	36.3	57.4	(not available)	48.4
May	51.5	72.7		59.2
June	59.0	79.7		69.1
July	59.1	80.3		72.9
August	58.1	79.5		70.7
September	51.2	74.6		63.7

Weather Data – 2000

Waterman Agricultural and Natural Resources Laboratory, Columbus, OH

Month	Rainfall (inches)	Long-Term Rainfall Average (inches)
April	3.56	3.70
May	4.77	4.40
June	3.02	4.50
July	4.38	4.70
August	4.77	3.70
September	6.57	2.90

	Air Temperature (^oF)			Long-Term Normal (^oF)
	Minimum	Maximum	Average	Average Temperature
April	40.7	63.0	51.7	51.1
May	54.3	76.5	65.7	61.4
June	61.0	81.9	71.4	70.4
July	61.8	82.7	72.4	74.2
August	60.6	82.3	71.5	72.6
September	55.0	76.1	64.5	66.1

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